Litter Rating and The Engineering Solution For Bandar Seri Iskandar

by

Adibah Bahriah binti Salleh

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Civil Engineering)

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CERTIFICATION OF APPROVAL

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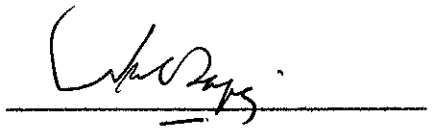
Approved by,



(Assoc Prof Dr Nasiman Sapari)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
January 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

ADIBAH BAHRIAH BINTI SALLEH

ABSTRACT

This project presents the finding of a study on litter survey to measure the litter density and litter rating in a randomly selected area in Bandar Seri Iskandar. The purposes of the project are to identify the severity of litter problem in the town and to determine the main compositions of the litter. Three main surveys conducted in this project were survey along roadside, survey on open area and drainage litter survey. The result shows that the level of litter problem in Bandar Seri Iskandar based on Litter Pollution Index (LPI) as moderately to significantly polluted. The compositions of the litter also were identified according to the categories based on usage. Litter survey along the roadside found that the visible litter is only one sixth (1:6) of the actual litter. Plastic bag constitutes the highest percentage of litter compositions with twenty-five percent (25%) followed by food wrapper and paper with 24% and 14%, respectively. Litter survey on open area proved the area without solid waste container has the higher amount of collected litter. 42 litters per 100 m^2 found in the area without solid waste container while only 5 litters per 100 m^2 collected from area provided with solid waste container. Drainage survey highlighted the drains located near commercial area has high tendency of litter accumulation. The possible causes and sources of the litter were identified based on their categories. Solutions to the litter problem are recommended by three approaches; engineering solution, management solution and educational solution. Recommendation for improvement in term of carrying out the survey as well as implementing the surveys is highlighted. The area of Seri Iskandar is concluded as moderately polluted, and the main compositions of the litter are wrapper and plastic packaging. The area of Bandar Seri Iskandar is concluded as moderately polluted with litter mainly plastic packaging (25%) and wrapper (24%).

ACKNOWLEDGEMENT

First of all, I would like to express my most gratitude to Allah S.W.T, for His Blessing, as I managed to carry out my Final Year Project; Litter Rating and The Engineering Solution for Bandar Seri Iskandar with success even though facing several obstacles through out the project.

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CHAPTER 1
INRODUCTION

1.1 Background of Study

Malaysia's continuous growth in various sectors especially economic and industries has led to an improvement of living standard, thus turned the nation into a consumer society. However, this situation has significant impact to the increment of municipal waste generation.

Waste is produced by every single human in most of their daily activities. Any item that has no value or benefits in the perception of the producer or the consumer is considered as waste. Generally, waste can be divided into different categories and further divided into more subcategories. However, the studies will only be focusing on solid waste. Solid wastes are defined as unwanted product or leftover arising from human and animal activities that are in solid form. Municipal solid waste (MSW) is one of the subcategory under solid waste that is produced mainly from residential, commercial, and institutional areas. However, included in this category as well are some industrial areas.

Litter is municipal solid waste that is not disposed of in a proper way. In a simple term, litter can be described as solid waste that has been thrown anywhere either on the roadside or open areas. Litter is generated by variety of potential source such as deliberate and accidental littering from vehicles, littering by pedestrians, illegal dumping, refuse sacks damaged while awaiting collection, and windblown farm and household material (Gray & Gray, 2004).

Currently in Malaysia, the total amount of municipal solid waste (MSW) reaches approximately 19,100 tonnes daily and is increasing at the rate of 3 percents (3%).

1.2 Problem Statement

Litter is an issues that faced by almost every country worldwide. Litter is said to increase along with the increase of the population as well as the development of the country. Behavior of the community and the availability of the facilities for the waste disposal have a significant impact on the amount of litter. Litter is not a new problem in any area in Malaysia. Illegal dumping area can also be found in area close to residential area which often can be seen along the roadside.

Seri Iskandar is situated along the major route, Federal Route 5 that is connecting Ipoh, capital of Perak and Lumut (Figure 1.1). This area is not excluded from facing this issue. Clearly seen plastic packages and paper bag are found in this area. As a main road, this route had been used by many travelers including tourists on a vacation to Lumut or Pulau Pangkor. Poor solid waste management that they may witness will give negative impression about Malaysians' attitude.

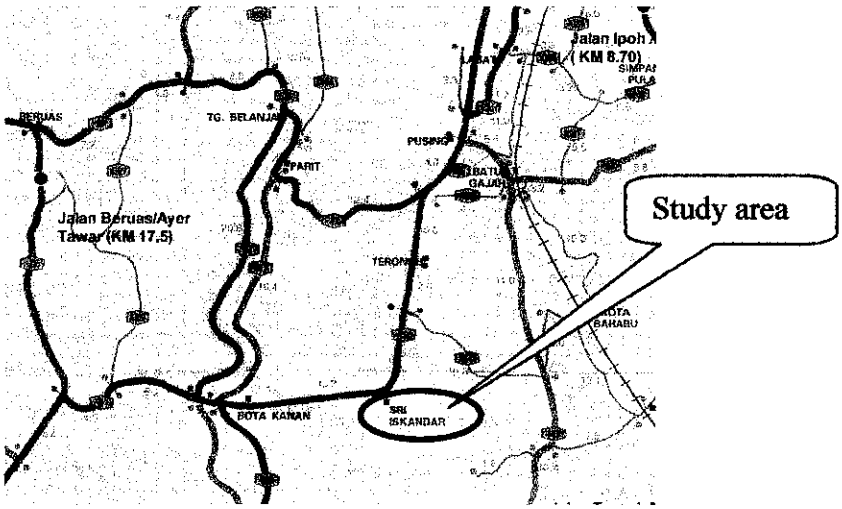


Figure 1.1: Location of Seri Iskandar in Majlis Daerah Perak Tengah

One of the community's main concerns is the discarded containers along the roadside and open spaces in urban environment may become breeding ground for mosquitoes. The containers will accumulate the rain water and provide suitable breeding environment for the mosquito. Health Ministry statement said vacant land formed the main breeding ground (7.4 percent) followed by government buildings and factories (5.3), health facilities (4), construction sites (3.4), rubbish dumps (2.7) and schools (2) (Bernama, 2007). These mosquitoes not only are a nuisance to the urban community, it can also become a vector to deadly diseases such as dengue fever. As from January to June 2007, there were 1555 dengue cases in Perak (Bernama, 2007). This number will be increasing if the breeding grounds for Aedes mosquito are not removed.

Seri Iskandar town is to be developed into the center of higher education of Perak. This fact gives a picture that there will be a rapid increment on the population in the area. As the population increases, the amount of litter also increases. Thus, it become crucial to understand the current situation of litter issues in this area in order to identify the root cause that lead to the problem and the preventive measures that may be taken in the future.

Serious problem may arise from a severe litter condition. Litter that had been swept by the air will accumulated at certain location and formed a dumping site along the road. Illegal dumping site without solid waste container and improper collection system attracted rats, cockroaches and flies to inhabit the area. These animals may cause nuisance to the community.

1.3 Objective and Scope of Study

The main objective of this study is to determine the litter index of Seri Iskandar town and to identify the major compositions of the litter. In order to achieve this objective, field work was conducted within the study area which in this case is the area of Seri Iskandar. This project covers three main on-site surveys which are:

- Litter survey along roadside
- Litter survey on open area
- Drainage litter survey.

Data from these surveys would be analyzed as follows:

- Classify the severity of litter in the specific area
- Identification of the major compositions of the litter
- Identify location of drainage that have the higher number of litter.

At the end of the study, suggestion or recommendation in term of mitigation or solution methods toward litter issue in Seri Iskandar will be made for the improvement of solid waste management in the Majlis Daerah Perak Tengah (MDPT).

As the topic can be divided further into various parts, for semester one, the study only focused on the first two survey works:

- Litter survey along roadside
- Litter survey on open area.

From the survey, litter parameters and the degree of litter in Seri Iskandar were identified. Comparisons were made with the result obtained at other locations within

Malaysia or worldwide. The main categories of materials based on its use that contribute to the litter problems were also determined.

For semester two, the studies were conducted in two parts. The first part is focusing on:

- Drainage survey
- Analysing, designing and recommending the solution.

Drainage survey would give data on the condition of the drainage with litter. Following these surveys is identification of some applicable mitigation and improvement steps that may be implemented in the area in order to enhance the solid waste management system in Seri Iskandar.

Refer to *Appendix A: Gantt Chart for Final Year Project 1 & 2* for further information on the work breakdown included in the scope of study.

CHAPTER 2
LITERATURE REVIEW

Currently in Malaysia, the total amount of municipal solid waste (MSW) reaches approximately 19,100 tonnes daily and is increasing at the rate of 3 percent (3%), which translate into 1.3 kg of MSW daily per person. At this rate of MSW generation and the population growth Malaysia will result in three percent (3%) average increase in total MSW generated annually (Agamuthu, 2007). Figure 2.1 represents the clear picture on current scenario of waste generation by every state in Malaysia.

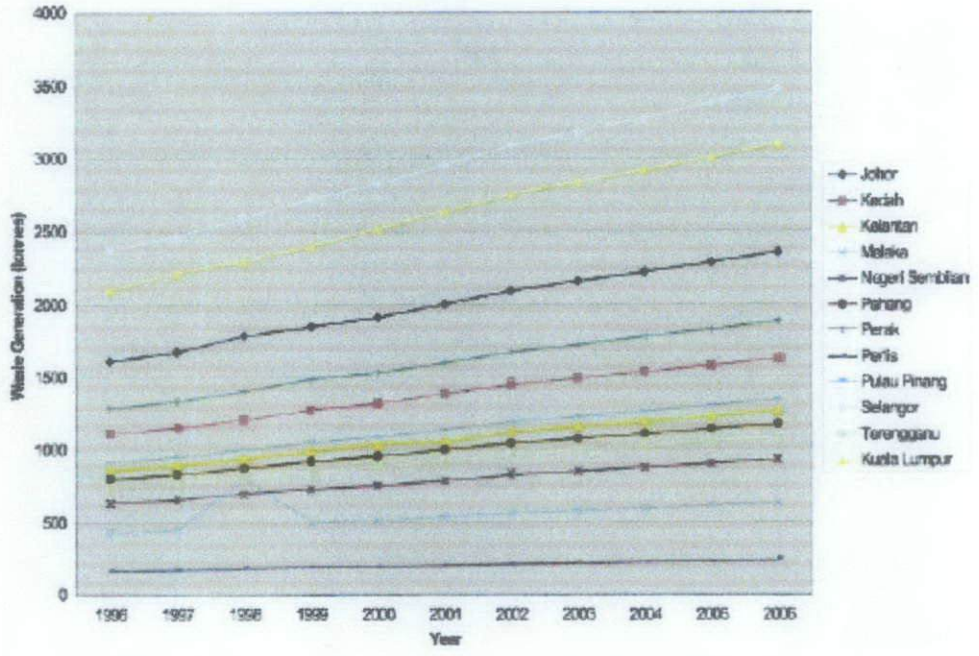


Figure 2.1: Trend in waste generation from 1996 to 2006 (Agamuthu, 2007)

It is believed that the composition of litter is dependent on the composition of municipal solid waste. Figure 2.2 shows the current trend on the composition of municipal solid waste in Malaysia. As shown by the graph, besides organic waste, it is predictable that paper and plastics constitute the major amount of the MSW.

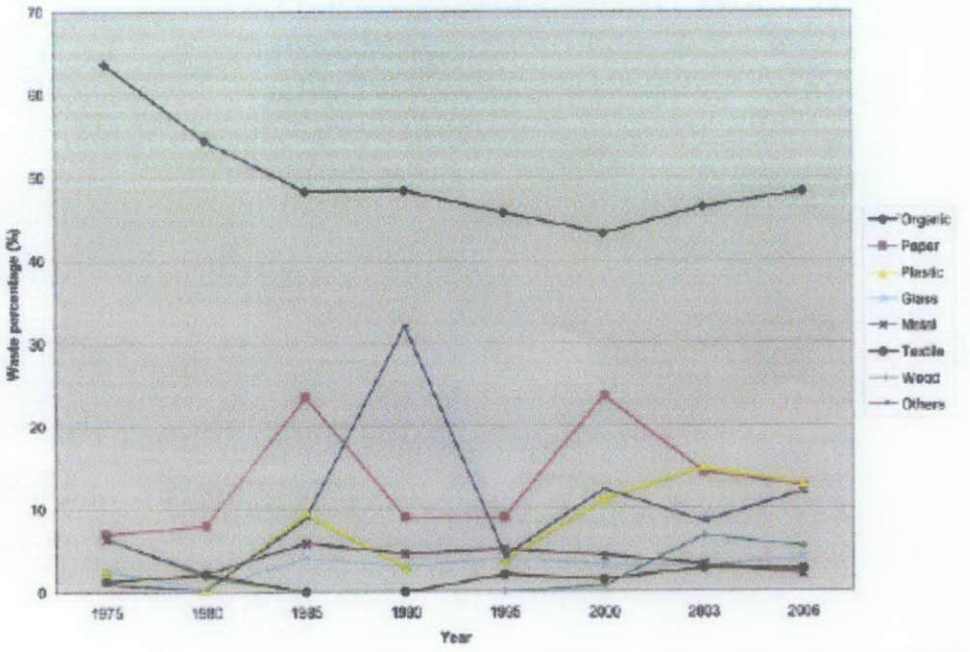


Figure 2.2: Malaysian MSW composition generated from 1975 to 2006 (Agamuthu, 2007)

2.1 Litter

There are several definitions can be found for litter. Generally, litter can be easily defined as any waste that is discarded improperly. Gary Gaulin (2005) from Clemson University Environmental Committee stated that "litter" is defined as carelessly discarded refuse consisting of waste items. On the other hand, council of City of Louisville (2008) accepted the definition of "litter" as anything that is left where it is not meant to be. Kentucky's Laws defined "litter" as rubbish, refuse, waste material, offal, paper, glass, cans, bottles, trash, debris or any foreign substance of whatever kind or description and whether or not it is of value.

To solve any issue or problem, it is important to identify the root cause or sources of the problem. As this study deals with municipal solid waste, the sources of the litter are generally come from the daily routine and economic activities of the community within the study area. However, Keep America Beautiful (2006) provided a list of specific activities considered as the primary sources of litter:

- Pedestrians or cyclists who do not use receptacles.
- Motorists who do not use car ashtrays or litter bags.
- Business dumpsters that are improperly covered.
- Loading docks and commercial or recreational marinas with inadequate waste receptacles.
- Construction and demolition sites without tarps and receptacles to contain debris and waste.
- Trucks with uncovered loads on local roads and highways.
- Household trash scattered before or during collection.

On the other hand, it is also a major concern to analyse and identify the reason and factor that lead people to litter. Through this identification, a better educational approach can be carried out in order to enhance the environment conscious of the community. Vesilind, Worrell, and Reinhart (2002) stated in order to determine the cause for a person to litter, studies on the psychology and behavior of litterer need to be conducted. From these studies, probability of a person to litter can be calculated based on the equation 2.1 below:

$$E = 0.019 + 0.414(A) + 0.1654(C) + 0.1532(D) \quad (2.1)$$

Where;

E = probability of a person would litter

A = 1, if the person is 18 years old or younger

C = 1, if there are no trash cans conveniently located

D = 1, if the area condition already dirty.

The above equation 2.1 provided the basic understanding on the major factors that lead a person to litter which are the age of a person, the availability of proper solid waste container and the condition of the area itself. Out of the three factors, the age of a person give the highest influence to the probability of a person to litter as shown by the highest coefficient value in the above equation.

To control litter problem, law governing the litter issue need to be imposed. Khoo (1998) highlighted, under section 8, Sandakan Municipal Council (Anti Litter) By-Laws 1984 stated "an offender under these by-laws shall be liable to a fine of not exceeding RM5, 000.00 and in the case of a continuing offence, to a further fine of RM200.00 for everyday during which the offence continues".

In United States of America, Boone County Solid Waste Management (2004) stated that according to Boone County law, a person can be fined between USD 100 to USD 500 or up to three days in jail or both if he or she is caught as offender under Ordinance 50: Improper Disposal as well as Ordinance 93: Discarding Items.

To increase the awareness of the public, local authorities had taken the initiative to put the litter signage that emphasize on the penalties that will be imposed to the offender.

2.2 Roadside Survey

Litter quantitative survey has been done on the analysis of highway litter, without a standard procedures or techniques to allow for accurate characterization (Gray & Gray, 2004). However, a few European countries and America had initiated certain method that can be adopted for determining certain litter parameters. Gary and Gray (2004) stated that accumulated litter (i.e., all the litter items at the time of collection) gives an

accurate estimation of litter density; fresh litter (i.e., litter that accumulates over a fixed time period after the site has previously been cleared of all accumulated litter items) allows the litter deposition rate to be estimated.

Florida Center for Solid and Hazardous Waste Management (1997) based its methodology on roadside litter because roadsides serve as a good collection point and indicator of the amount of litter in the environment. Roadsides are relatively standard on a statewide basis and a statistically valid sampling program for roadsides was relatively easy to develop. Since roadsides are easy to access and measure, most litter surveys conducted in the United States have focused on roadsides as a point of litter measurement.

As a first step, survey sites is selected randomly (sites were not selected as their heavily littered condition are known). Two methods have been used for the roadside litter survey. For the first method, survey is carried out along the road and number of litter counted as per mile. The second method is conducted by selecting 24 random sites along the road with each site covers 50m section of the road. There was also a practice to select the number of sites according to the area of the study with each sample area covers 200 feet length of the road.

According to Florida Center for Solid and Hazardous Waste Management (1997), visual inspection need to be conducted for the site in order to determine the present of any element that may cause the site to be unsuitable for the study. The rejection criteria included:

1) surveyor safety and security concerns,
2) construction on site,
3) site location on a bridge,
4) highway cleanup crews within one mile of the site,

5) evidence of Adopt-A-Highway litter cleanup activity within the site,

6) majority of site submerged in water,

7) site located on an interstate highway within one mile of an interchange, and

8) no grass or soil on the right-of-way.

Litter survey should be started by driving along the road at a slow speed and having a passenger record the visible items into a tape recorded for future transcription. Next, the litter is identified, recorded and manually collected. The items should be separated during collection and into as many components as feasible. The collected items are then weighed and the volume measured (Vesilind, Worrell, & Reinhart, 2002).

Florida Center for Solid and Hazardous Waste Management (1997) also provide other method of the study that does not required manual collection. The surveyor needs to walk along the selected site with normal speed in meandering fashion. The survey began at the corner of the site nearest to his or her vehicle. The surveyor recorded on a tape recorder a description of each piece of litter observed on the site that was equal to or larger than 4 square inches in size. Each site was surveyed twice by making two separate passes, one beginning at the side nearest the vehicle and the second pass going back toward the vehicle. This method provided a check on the surveyor's accuracy. Items not visible on the first pass because of the light or lay of the grass might be visible on the second pass in the opposite direction. An average was taken of the items counted on the two passes.

2.3 Visual Assessment

As taken from The Litter Monitoring Body (2007), Litter Pollution Index (LPI) is evaluating the extent and severity of litter pollution in a scale of 1 to 5 as described below:

1. Unpolluted or litter free
2. Slightly polluted
3. Moderately polluted
4. Significantly polluted
5. Grossly polluted.

To establish a comparison and determine the yearly improvement, the same sites should be evaluated each year using a team of at least three people. Each scorer independently ranks the site (Beck, 2007).

However, there is no clear relation that can be concluded between the site survey and visual assessment as the research on evaluating and synchronizing the result of site survey and visual assessment is still conducted by the responsible authority and department.

Refer to *Appendix B: Example of Litter Area by Scales* for clear visualization understanding.

CHAPTER 3
METHODOLOGY

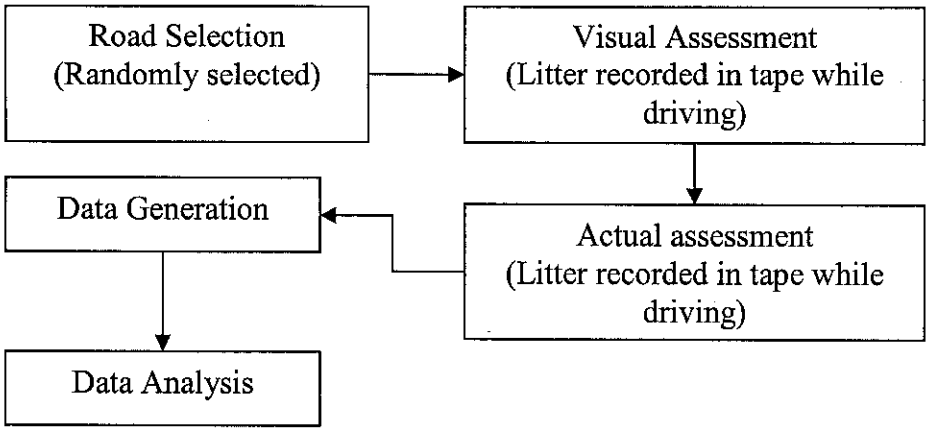
3.0 Survey

The project begins with identification of the problem statement as well as the study background by conducting research work on published materials in journals and books for the references throughout the project. A timeline also had been established in order to meet the due dates for accomplishing certain phase of the project.

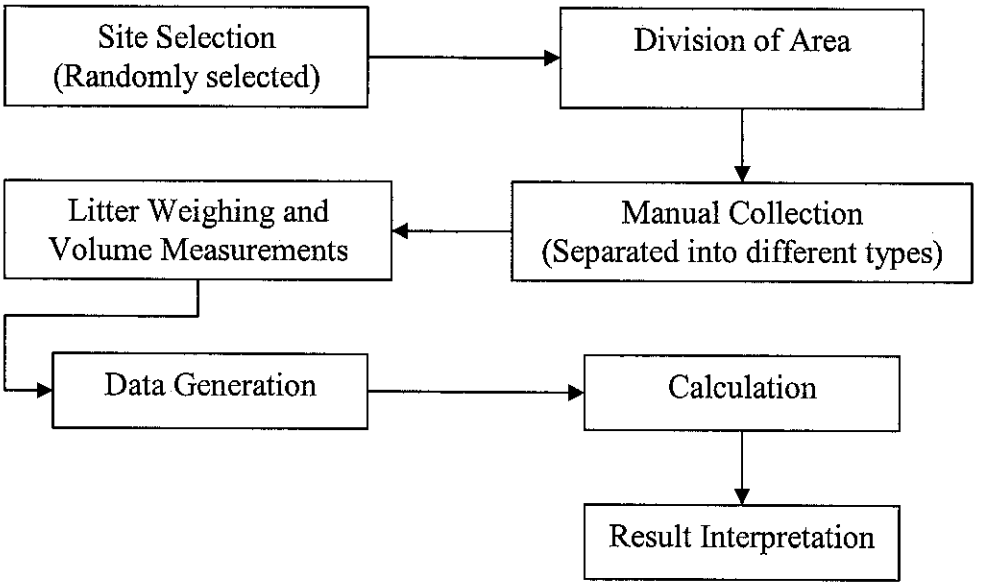
For the field work of the project, the tasks involved three surveys that need to be completed within the specific timeframe. Some general guidelines for the surveys are:

- Only item with size larger than 2.5cm (1 in.) are to be counted
- All pieces of any item clearly belonging together is counted as one
- All bottles and cans need to be emptied before collecting them
- Animal dropping, rocks, dirt or readily decomposable material are not included.

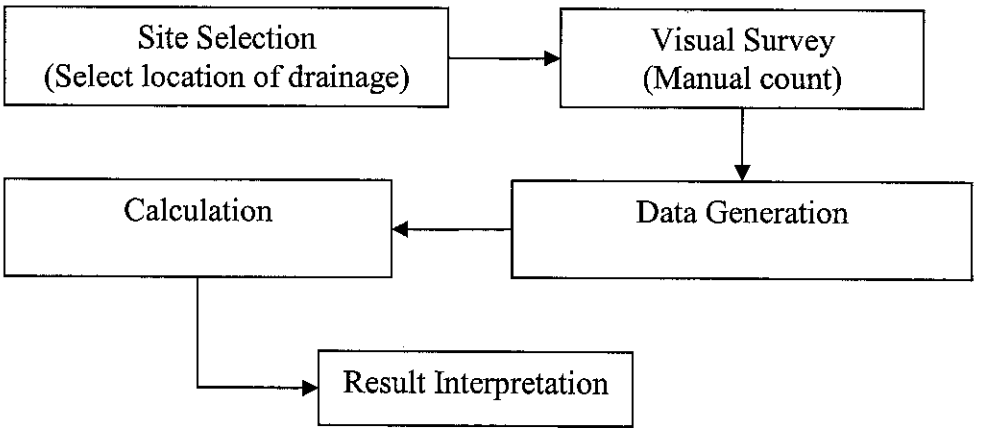
3.0.1 Work Flow: Litter survey along roadside



3.0.2 Work Flow: Litter survey on open area



3.0.3 Work Flow: Drainage litter survey



Once all the data has been gathered and interpreted, the result are presented in understandable manner with proven justification.

3.1 Site Selection

The first step for case study was to determine the area included in the study. The boundary of the study area was determined properly as the study involves with a lot of field work and on-site survey. Unclear boundary may lead to collection of sample beyond the boundary of the study area that may result in inaccurate data generation. The area of Seri Iskandar (Figure 3.1) has been selected as the case study for this project. Included in this define area are the Seri Iskandar Town which are Seri Iskandar Government Complex, institutional areas and a few nearby residential area such as Taman Maju, Bandar Universiti and Taman Teknologi Bandar Seri Iskandar.

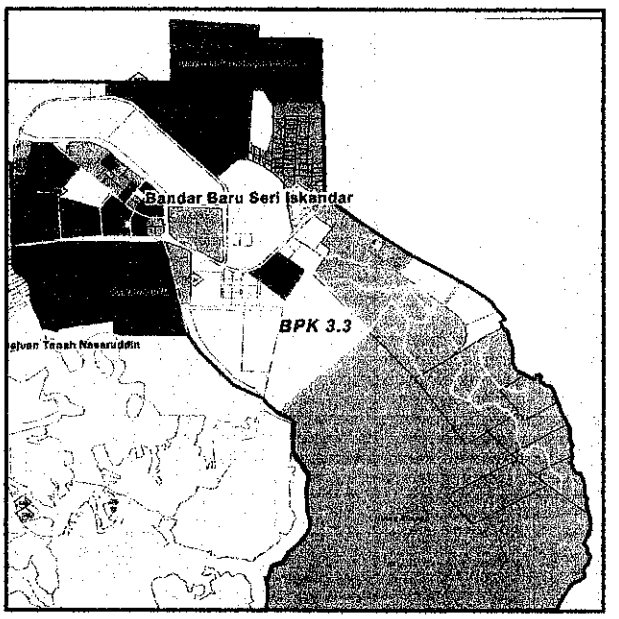


Figure 3.1: Map of Bandar Seri Iskandar

3.1.1 Litter survey along roadside

As there is no specific standard on the selection for this survey, the site selections were base on the common practice. At first, the roads within the study area were classified according to the types base on the characteristic and activity around the road:

- Rural: road along agriculture area with minimum number of houses
- Urban: main route and have higher population area
- Residential: road in area where the primary land uses are housing
- Industrial: road with the main activity within the area is industry.

For this case study, the selected roads in Seri Iskandar area are only urban and residential road.

For the beginning of the study, there was an intention to include a portion of main road (Federal Route 5) that is connecting Ipoh and Lumut as one of the sample area. Unfortunately, most section of the main road within the study area is under on-going construction activities. Thus, the survey cannot be carried out at the main road as it is not advisable to include areas which are under construction as the sample area (The Florida Center, 1997).

Selected sample areas:

- Entrance road of Bandar Universiti – two (2) sample areas (Figure 3.2)
- Pekeliling Iskandar Perdana 8, Taman Teknologi Bandar Seri Iskandar – one (1) sample area

The locations of each sample area are shown in Figure 3.3 and Figure 3.4.

Figure 3.2: Sample Area Road 2, Entrance road of Bandar Universiti

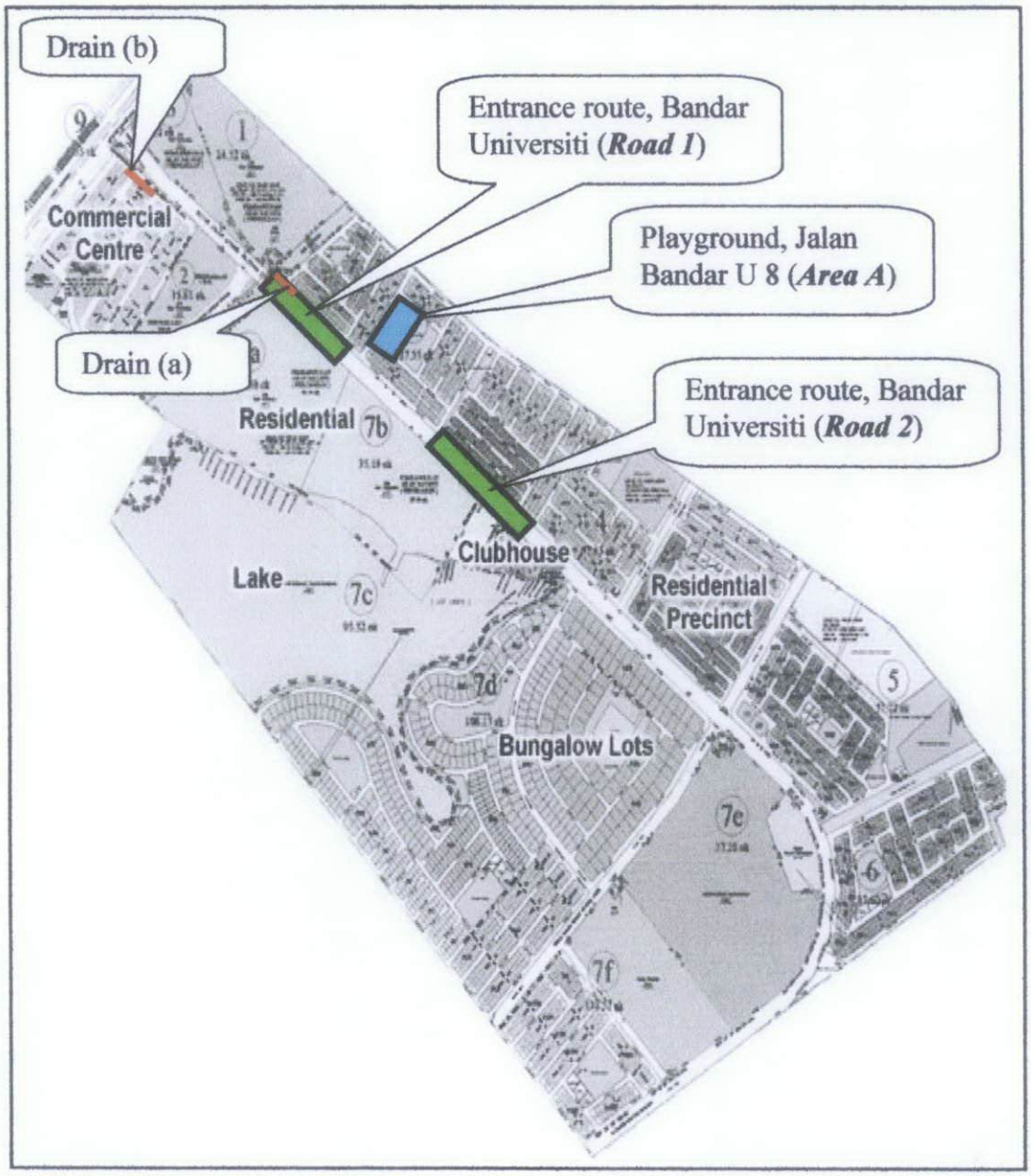


Figure 3.3: Map of Bandar Universiti Seri Iskandar

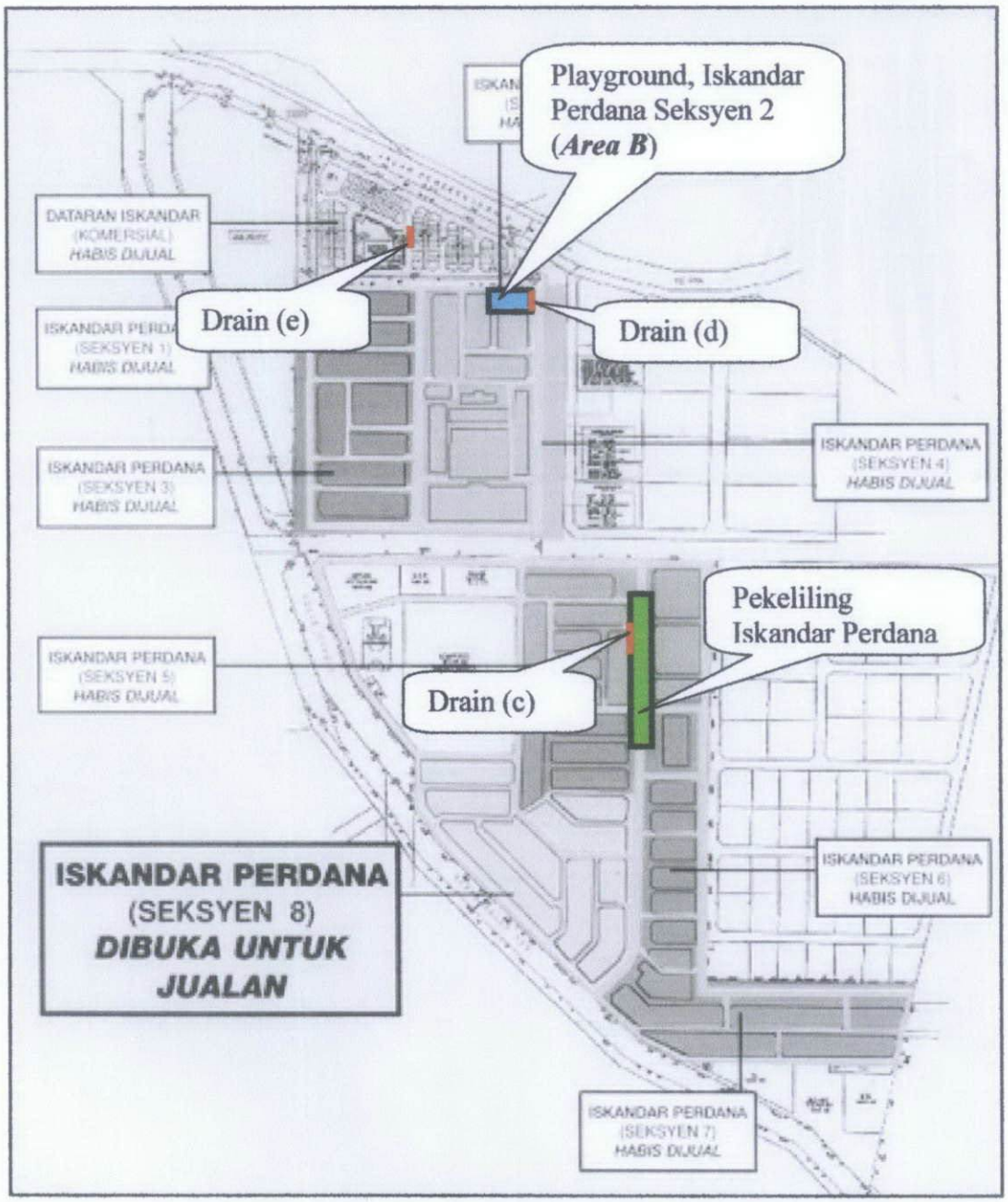


Figure 3.4: Map of Taman Teknologi Seri Iskandar

To avoid miscalculation on the length of the sample area, landmarks such as buildings, trees and road intersections were used to identify the starting point and end point of the sample area. Distance between the two landmarks was calculated as the length of sample

area. The sample area included two-lane two-direction and one-lane two-direction roads with the width of 10 feet to 20 feet.

3.1.2 Litter survey on open area

Open area can be divided into vacant lot, field as well as playground. Based on visual survey, most vacant lot in the study area are covered with grass and bush up to approximately 3 feet tall. Safety is quite a concern in order to conduct the survey in the vacant lot area. Thus, the focus was more on field and playground.

Selected sample areas:

- Playground, Jalan Bandar U 8, Bandar Universiti
- Playground, Iskandar Perdana Seksyen 2, Taman Teknologi Bandar Seri Iskandar.

The locations of each sample area are shown in Figure 3.2 and Figure 3.3. There is no standard size for the playground area. Size of the sample areas are base on the area covers by the playground itself.

3.1.3 Drainage litter survey

Drainage systems within the study areas was divided into drainage near commercial area, drainage along the roadside and drainage at community or residential areas. The selected length of drainage should represented one of the stated categories. For each selected drainage, a length of five (5) meters from the total length of the drainage were taken as the sample areas.

Five sites selected as the sample areas were:

- Drainage at the commercial area along the entrance route of Bandar Universiti
- Drainage at the commercial area in Bandar Universiti
- Drainage along Pekeliling Iskandar Perdana 8, Taman Teknologi Bandar Seri Iskandar
- Drainage bordering the playground at Iskandar Perdana Seksyen 2, Taman Teknologi Bandar Seri Iskandar.
- Drainage at the commercial area of Taman Teknologi Bandar Seri Iskandar.

The locations of each sample area are shown in Figure 3.2 and Figure 3.3.

3.2 On-Site Survey

3.2.1 Litter survey along roadside

On-site survey was conducted by two means; visible assessment and actual assessment. The survey was conducted on both direction of the road within the length of the sample areas. Visible assessment was carried out by driving along the sample area with slow speed, approximately 20km/hour with an assistant recorded the visible litter according to the uses and types. Actual assessment was conducted by walking along the same sample area in meandering fashion and once again recorded every single visible litter within the road right-of-way until the boundary of the road such as drainage or fence.

3.2.2 Litter survey on open area

Survey was conducted by manual collection. General guideline need to be followed in order to ensure the reliability of the data collected. The collected litter was categorized into a few major types namely plastic, paper, wrapper and box.

3.2.3 Drainage litter survey

Survey was conducted by manual counting. Measuring tape was used to measure the needed length of sample areas. The beginning and end of the survey lengths were marked with marker pen. Manual counting was done by walking along the length of sample areas while counting any litter found that has the size larger than 2.5cm.

3.2.4 Challenges for on-site survey

Some of the sample area had been disturbed by stray cat and dog with packs of garbage taken from nearest residential area. The packs also had been torn and most of the fill were spread within the sample area. Thus, there were some difficulties to differentiate the litter with the garbage from the packs.

Some litter that had not been collected for long period of time was exposed to weathering and thus undergoes decomposition process. These litters become harder to be identified and classified according to the categories as it already loses the original form.

Weather also has a large impact on the on-site survey as rainy season causes the surveys need to be delayed. It is difficult to conduct the survey in rain as all the litter that need to be collected were wet and collecting wet samples required extra task which is to dry the samples. Rainy days also made the drainage survey impossible as the edge of the drainage become slippery and thus it is dangerous to walk along the edge.

3.3 Data Generation and Analysis

3.3.1 Litter survey along roadside

The record tapes were played and the litter types are tabulated in table form in Excel. Numbers of litters for each category were counted. Further calculation was conducted to determine the accumulated value, total value and percentage of each categories of litter. From all the value obtained, the required graphs and charts are produced.

3.3.2 Litter survey on open area

The litters collected were clean from debris and dry. Then, they were sorted according to their categories. Each type of litters was put in different container. The weight and volume for each category is measured. Later, the density is calculated.

3.4 Visual Assessment

Adapting from the practice of Ireland's National Litter Pollution Monitoring System, visual assessment were conducted to determine Litter Index. The severity of litter pollution for the specific sample areas are indicated by the scale of Litter Pollution Index (LPI) as listed below:

1. Unpolluted or litter free
2. Slightly polluted
3. Moderately polluted
4. Significantly polluted
5. Grossly polluted.

The visual assessment was conducted at the same sample areas for litter survey along the roadside. Comparing the condition of the sample areas with the guideline as in *Appendix B*, each of the sample areas were rated individually.

As there is no record of such assessment been conducted in Seri Iskandar town, the result obtained from this study is considered to be the benchmark and reference for future studies on severity of litter problem in this town in order to determine the yearly improvement.

3.5 Hazard Analysis

Hazard Analysis is a series of steps taken in order to identify the potential hazard or safety issue that need to be taken into account during carrying out the task. Each specific activity within the task need to be examined carefully for any hazard that need to be consider and come out with the safest method to perform the activities.

There are four general steps that need to be performed in Hazard Analysis:

- selecting the job to be analyzed
- breaking the job down into a sequence of steps
- identifying potential hazards
- determining preventive measures to overcome these hazards.

Some of the questions that may be useful in establishing the potential hazard are:

- Is it possible for any body part to be trapped in or between the objects?
- Is there any hazards using these tools or machines?
- Is there any possibility for slip, trip and fall in this condition?
- Can the weather condition affect the health and safety?
- Does the air contain excessive amount of dusts and fumes?
- Can a person sustain this level of noise and vibration?

- Is there a possibility for objects to fall from above?

Table 3.1 below shows the potential hazards during carrying out the final year project.

Table 3.1: Final Year Project Hazard Analysis

Sequence of Events	Potential Hazard	Preventive Measure
Survey along Roadside	i. Car accident	• Drive within speed limit • Abide road rules and regulations • Be extra careful • Focused during driving.
Survey on Open Area	i. Step on sharp items	• Clear the walking path • Always look to the ground before take a step • Always bring first aids kit.
	ii. Bitten by dangerous or poisonous animals	• Wear long pant and full covered shoes • Bring a stick when moving in or between bushes • If not necessary, avoid walking pass through bushes.
Drainage Survey	i. Slip, trip and fall	• Avoid walking at the edge of the drainage • Wear proper and non-slippery shoes.
Report Preparation (involve with computer)	i. Ergonomic	• Make sure seat in a good condition • Hand position not too high or too low • Keep distance from the screen.
	ii. Eye tiredness	• Take some rest at specific time interval
	iii. Electrical shock	• Do not drink near the computer • Make sure hands are dry while using computer.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Litter Survey along Roadside

4.1.1 Visible and actual litter

Results from the survey show, a total of 381 items were observed clearly during the visible count conducted from a car with a speed of 20 km/hour. However, 1822 items were identified when manual observation by walking was carried out. Table 4.1, 4.2 and 4.3 show the result of the observation for all the three survey areas.

Table 4.1: Roadside Survey for Road 1

Categories	Side (a)		Side (b)		Total	
	Visible	Actual	Visible	Actual	Visible	Actual
Plastic Bag	23	71	16	50	39	121
Plate	0	3	0	5	0	8
Food Wrapper	38	116	5	29	43	145
Packet Drink	3	20	6	7	9	27
Plastic Bottle	2	15	5	5	7	20
Glass Bottle	0	2	0	1	0	3
Straw	6	22	0	8	6	30
Paper	4	74	4	32	8	106
Tin	1	4	1	1	2	5
Box	4	4	6	6	10	10
Cigarette Box	0	11	11	26	11	37
Cup	8	25	0	5	8	30
Clothes	1	3	1	3	2	6
Tissue	1	14	0	4	1	18
Others	0	21	4	19	4	40
Total	**91**	**405**	**59**	**201**	**150**	**606**

Table 4.2: Roadside Survey for Road 2

Categories	Side (a)		Side (b)		Total	
	Visible	Actual	Visible	Actual	Visible	Actual
Plastic Bag	41	115	20	112	61	227
Plate	1	2	1	1	2	3
Food Wrapper	1	72	7	51	8	123
Packet Drink	4	22	3	4	7	26
Plastic Bottle	5	16	7	21	12	37
Glass Bottle	0	2	0	5	0	7
Straw	5	31	0	8	5	39
Paper	5	57	4	46	9	103
Tin	0	0	0	3	0	3
Box	1	6	0	7	1	13
Cigarette Box	5	16	7	25	12	41
Cup	2	19	0	4	2	23
Clothes	0	5	2	2	2	7
Tissue	0	1	0	3	0	4
Others	0	16	7	31	7	47
Total	**70**	**380**	**58**	**323**	**128**	**703**

Table 4.3: Roadside Survey for Road 3

Categories	Side (a)		Side (b)		Total	
	Visible	Actual	Visible	Actual	Visible	Actual
Plastic Bag	2	42	13	59	15	101
Plate	0	6	0	12	0	18
Food Wrapper	13	79	26	87	39	166
Packet Drink	4	18	0	8	4	26
Plastic Bottle	4	16	6	11	10	27
Glass Bottle	0	1	0	1	0	2
Straw	10	32	3	8	13	40
Paper	3	30	1	24	4	54
Tin	0	3	0	0	0	3
Box	0	0	1	1	1	1
Cigarette Box	6	19	8	15	14	34
Cup	0	0	0	5	0	5
Clothes	0	3	0	3	0	6
Tissue	1	5	0	5	1	10
Others	2	9	0	11	2	20
Total	**45**	**263**	**58**	**250**	**103**	**513**

Table 4.4 was developed from the collected data to determine the rate of litter per 100m of the sample area. An average litter density of 247 items/100m and 52 items/100m was found for the actual and visible litter respectively. These figures were obtained from a total survey length of 736.44m.

Table 4.4: Summarize of Cumulated Litter

Sample Length (m)	Cumulated Sample Length (m)	Litter		Cumulated Litter		Items/100m	
		Visible	Actual	Visible	Actual	Visible	Actual
0	0	0	0	0	0	0	0
270.83	270.83	150	606	150	606	55	224
287.21	558.04	128	703	278	1309	50	235
178.4	736.44	103	513	381	1822	52	247

To clearly observe the trend, the above data is used to generate the following graph (Figure 4.1). Both the table and graph show the visible litter is only about one sixth (1:6) of the actual litter.

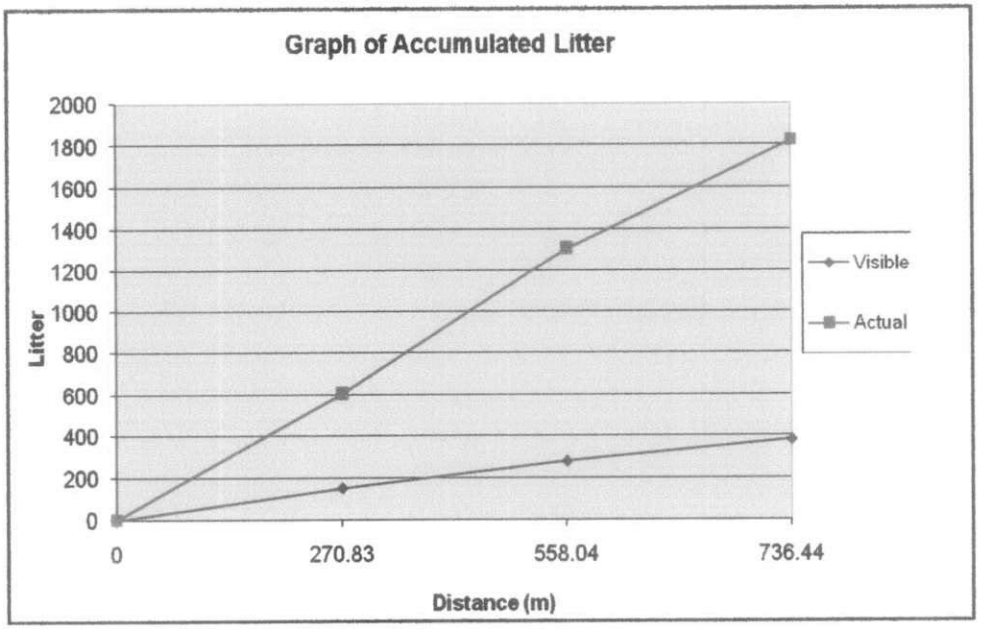


Figure 4.1: Graph of accumulated litter

4.1.2 Litter by categories

The survey items were categorized according to its use and material (Table 4.5) in an attempt to identify the dominant type of material that constitutes the most number of litters. Some categories only consist of only one single type of item, but the other comprises of a few types that either shares the same materials or use.

Table 4.5: List of categories by use

Plastic Bag Plastic	**Glass Bottle**	**Cigarette Box**
Plates polystyrene	**Straw**	**Cup** Plastic reusable Polystyrene foam cup Paper cup Plastic lids
Food wrapper Snacks plastic Paper wraps Foil Labels	**Paper** Newspaper Advertisements	**Clothes**
Packet drink	**Tin** Drink can Glue tin	**Tissue**
Plastic Bottle	**Box**	**Others** Rope Culinary items Shoes' components

For Seri Iskandar area, fifteen (15) main categories were established and all the litters in the area included in either one of the category. Figure 4.2 shows the comparison of number of litter between visible and actual as well as the different in number of litters by categories.

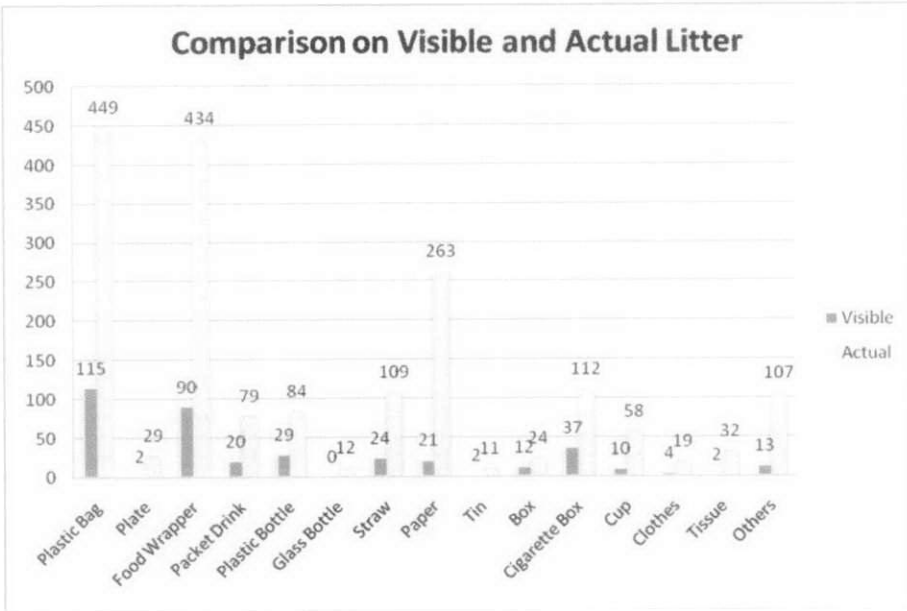


Figure 4.2: Comparison between visible and actual litter

Plastic bag constitutes 24.6 percent of the total actual litter followed by food wrapper and paper with 23.8 percent and 14.4 percent respectively. All the other types of litters each constitutes less than 10 percent, with the higher number found in descending order: cigarette box (6.1%), straw (6%), others (5.9%), plastic bottle (4.6%), packet drink (4.3%), cup (3.2%), tissue (1.8%), plate (1.6%), box (1.3%), clothes (1%), glass bottle (0.7%) and tin (0.6%).

As most of the survey areas are of residential type, as expected, plastic bag and food wrapper constitute the large percentage of litter. In Malaysia, plastic bag are widely use as packaging material either from grocery shop or hypermarket. This type of plastic bag come with different sizes and light in weight that makes it easy to be blown by the wind. Perhaps the lack of environment conscious among the residents, is the reason for food wrappers made of plastic, paper or foil are dumped anywhere after all the content have been consumed. Where as, papers usually are used for advertisement and posted on the wall and lamp post. These papers were easily torn especially during rainy and windy seasons. Rain water may soften the paper and strong wind could blow the paper away.

Some of the papers are from part of the newspaper. Newspapers that are left unattended will be blown by the wind and scattered.

4.1.3 Comparison with other areas

Comparison had been made between the area of Bandar Seri Iskandar with two other areas namely; the state of Georgia, United State of America and Ireland. Although the scale of the survey are different and the geographical area also different, this comparison attempted to provide some benchmark on the severity of the litter problem in Bandar Seri Iskandar. Table 4.6 below shows the different in term of percentage of litter between the three areas.

Table 4.6: Difference of litter in percentage between Seri Iskandar, Georgia and Ireland

Categories	Percent (%)		
	Seri Iskandar	Georgia	Ireland
Plastic Bag	24.6	22.3	0.52
Plate	1.6	3	-
Food Wrapper	23.8	9.4	26.42
Packet Drink	4.3	0.3	0.82
Plastic Bottle	4.6	1	2.06
Glass Bottle	0.7	3.4	0.69
Tin	0.6		1.16
Cup	3.2	6.7	1.04
Straw	6		1.24
Paper	14.4	20.3	2.2
Box	1.3	-	0.17
Cigarette Box	6.1	2	2.88
Clothes	1	1.7	-
Tissue	1.8	4.6	0.77
Others	5.9	18.1	0.3

However, this comparison does not comprise the whole 100 percent of total litters in Georgia and Ireland as there is a difference in term of categorization. Thus, only categories of litter that are similar or nearly relevant to the categories of litters in Bandar Seri Iskandar are taken into account.

Refer to *Appendix C: Results for Ireland and Georgia Base on Litter Categories* for further details of the litter distribution by categories of the two areas.

4.1.4 Litter Pollution Index (LPI)

Implementing the visual assessment based on the Litter Pollution Index (LPI), the three survey roads can be rated as follow:

- Road 1: 4 (Significantly Polluted)
- Road 2: 4 (Significantly Polluted)
- Road 3: 3 (Moderately Polluted).

As there is no previous record on Litter Pollution Index (LPI) for Bandar Seri Iskandar, increment or decrement of the rating cannot be determined. However, this information may be useful for future reference in order to determine the improvement of litter problem in this area.

4.2 Litter Survey on Open Area

Two selected playgrounds were determined as the survey area. The surveys at both areas were conducted in early of September 2007. The areas are rectangular in shape and the area covered in the survey are:

- Area A: Playground at Jalan Bandar U 8 = 1941.42 m^2
- Area B: Playground at Persiaran Iskandar Perdana 10 = 6276.07 m^2.

Number of litter collected for each sample area:

- Area A = 821 items
- Area B = 334 items.

Figure 4.3 and Figure 4.4 below show the number and weight of the collected litter based on the categories of the litter.

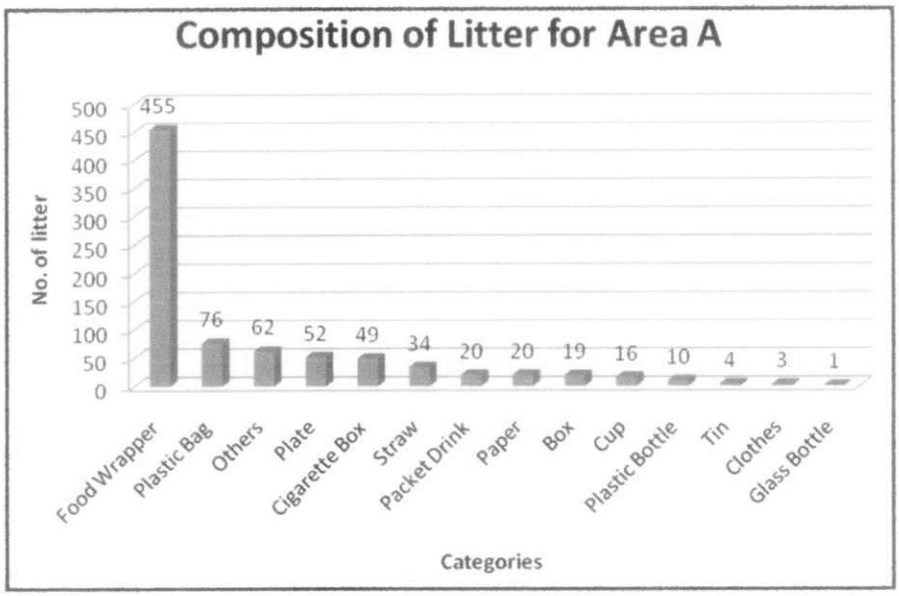


Figure 4.3: Composition of litter for area A

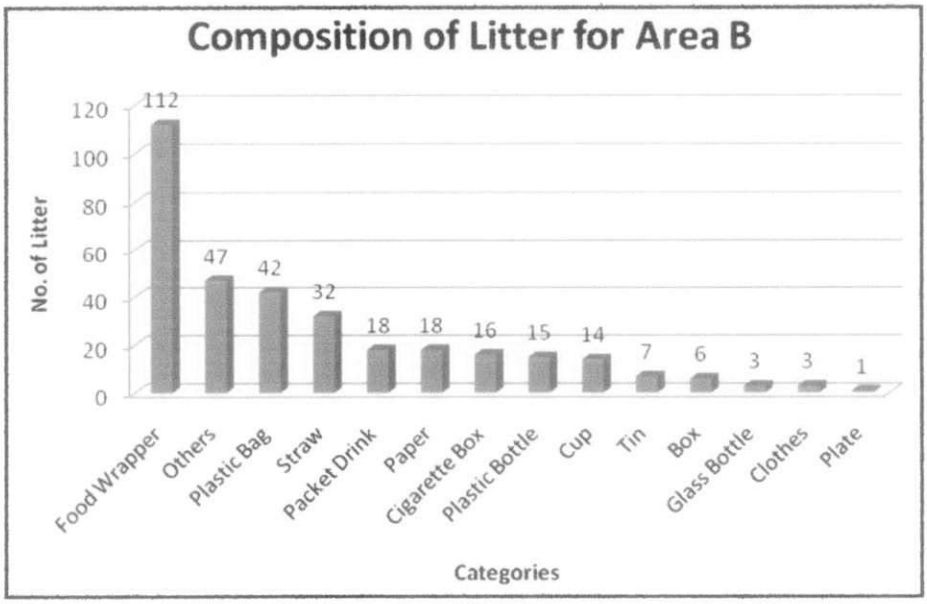


Figure 4.4: Composition of litter for area B

Thus, from the above information, the density of litter for each area is:

- Area A: 821 x 100 m^2 / 1941.42 m^2 = 42.29 items/100m^2 = 42 items/100 m^2
- Area B: 334 x 100 m^2 / 6276.07 m^2 = 5.32 items/100m^2 = 5 items/100m^2.

Refer to *Appendix D: Results for Litter Survey on Open Areas* for the information on the raw data of the survey.

Comparing both areas, Area B has less number of litters per 100m^2. It is because this area is provided with a few solid waste containers. However, litter still exist due to poor litter collection system. All the solid waste containers were always full and not emptied according to schedule. Figure 4.5 shows the condition of the dustbin in Area B.

The highest composition of litter for both areas is food wrapper. 455 food wrappers were collected in area A from overall number of litter 821 items. While, 112 food wrappers were collected out of 334 total litter in area B. These figures indicated that food wrappers constitute 55.4 percent and 33.5 percent of overall litter in area A and B respectively. It is predicted as most visitors to the areas are children and teenagers which synonym with snacks and sweets.

Figure 4.5: Dustbin in Area B

4.3 Drainage Survey

Data from five different survey sites is compiled in table form for comparison and analysis. Litter is observed and counted manually for sixteen feet (approximately 5 meters) of length in each survey sites. Then, the number of litter for one meter of sample length was calculated. The survey data collected from five different sites shows a big range of number of litters from as low as five (5) litters for the length of sample area in drain (b) to sixty-five (65) litters were counted in drain (e). Table 4.9 below shows the number of litter on five drains in Bandar Seri Iskandar.

Table 4.7: Data and result of drainage survey

No.	Sample of Drain	Remark (area)	Length (m)	No. of Litters	No. of Litters / meter
1	Drain (a)	Commercial and Main Road	5	10	2
2	Drain (b)	Commercial	5	5	1
3	Drain (c)	Residential	5	11	2.2
4	Drain (d)	Residential	5	8	1.6
5	Drain (e)	Commercial	5	65	13

Referring to the data above, the number of litter in the drain for Seri Iskandar area is influence by the location of the drain. The number of litter in drain (a) which is located adjacent of the road from a commercial area in Taman Bandar Universiti can be consider low as for one meter length, only two litter can be found. While, for drain (b) (Figure 4.6) that is located adjacent of the commercial building along the entrance to Taman Bandar Universiti, there is about a litter can be seen in every one meter length.

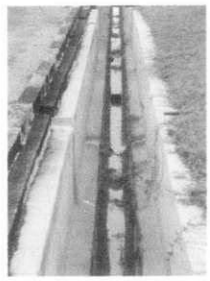


Figure 4.6: Drain (a) at shop lot near entrance route Taman Bandar Universiti

For drain (c) and drain (d) that are located by the roadside of Jalan Pekeliling Iskandar Perdana 8, and near the playground area of Iskandar Perdana Seksyen 2 at Taman Teknologi Seri Iskandar, respectively, approximately two pieces of litter can be found in every one meter length of the drain. While, the number of litter in drain (e) bordering the commercial building in Taman Teknologi Seri Iskandar can be said as high as for every one meter of sample length, there were thirteen litter.

There is a clear picture that the litter in drainage system of Taman Bandar Universiti is lower compared to the drainage system of Taman Teknologi Seri Iskandar. One possible reason is a probability due to Taman Bandar Universiti has more establish cleansing system because the area is holder area.

Comparing drain (c), (d) and (e) that are located in different area within Taman Teknologi Seri Iskandar, the results clearly indicate that the drainage system near the commercial lot has higher number of litter per meter. This area is a new area but more active business area. Therefore, more materials are being generated in the area. The improper dumping of waste may have attracted animals and later blown by the wind. Thus, some of the litters end up accumulating in the drain.

One of the important factors that also lead to the accumulation of litter in drain and finally blocked the drain is the condition of the drain that is not properly check and maintained. Figure 4.7 and Figure 4.8 below show the condition of some portion of the drainage system in Seri Iskandar town that has not been inspected and cleaned regularly. Grass that grows in the drainage system not only trapped the litter but also reduced the capability of the system to allow water to flow.

Figure 4.7: Grass and plant grow in the drainage system

Figure 4.8: Water and litter trapped by the grass

In some area, the left over materials from construction as well as pieces of crush structure accumulated in the drain and were not removed for some time also caused the blockage to the drainage system and allow the accumulation of litter as well as water as shown in Figure 4.9.

Figure 4.9: Concrete blocks form blockage in drainage

4.4 Litter Control

As the litter surveys conducted covers the road, open area and drainage areas around Bandar Seri Iskandar, this studies proceed with the identification of possible prevention and mitigation solutions that may be considered for future litter control. Three major components of litter controls taken into account are; engineering, management and educational solutions.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The case study requires more time for on-site survey. Reliable data need to be collected in order to produce accurate result and correct information on the current litter condition of the study area. As there is no standard method to conduct the litter survey, some modification was made to the current practice in America and European countries in order to ensure the suitability of the survey to be conducted within the local geographical area and social activities.

This study shows that wrapper and plastic packaging constitute 48.4 percent (48.4%) of the total number of litters. This result clearly indicate that the litter are coming from the food wrapper and items that has been discarded for long time until it was blown by the wind or transported by water. Paper contributes 14.4 percent (14.4%) of the total litters including newspaper, advertisement and miscellaneous paper. Newspapers that are left unattended and advertisement papers that had been glued to the wall or lamp post outworn as time passes would be easily blown by the wind.

The number of litters in the drainage system within Seri Iskandar town varies according to the location of the drain. Drain near the commercial building has the tendency to have higher number of litter per meter. Lack of control, stray animals and litter blown by the wind are contributing factors for litter accumulation in the drainage system. The litter

that have been unattended for long period of time are causing blockage to the drain. Grass and concrete blocks in the drain make the situation become worse.

Litter has been a problem at many local authorities. Economic growth has significant contribution to the solid waste generation. Increment of litter effect the environment of the area and health of the community. Thus, it is very important to have a reliable analysis in order to enhance mitigation and prevention steps to ensure that the correct measurements are taken into account.

5.2 Recommendation for Litter Control

5.2.1 Engineering solution

5.2.1.1 Recommendation 1: Solid Waste Trap

A cage with a steel structure covered with wire mesh inserted in the sandtrap is recommended for the purpose of trapping any solid waste wash by the water that flow in the drainage system. Figure 5.1 shows the three-dimension (3D) drawing of the solid waste trapping cage. This cage is installed in order to prevent accumulation of solid waste in the sandtrap and eventually disturbed the water flow. This disturbance may cause water ponding that may provide breeding ground for mosquitoes as well as discomfort to the community due to smell it produced.

To ease the collection process, this cage is made to be able to rotate where the solid waste collector only needs to lift it up during collection and put it back to its original location after it has been emptied.

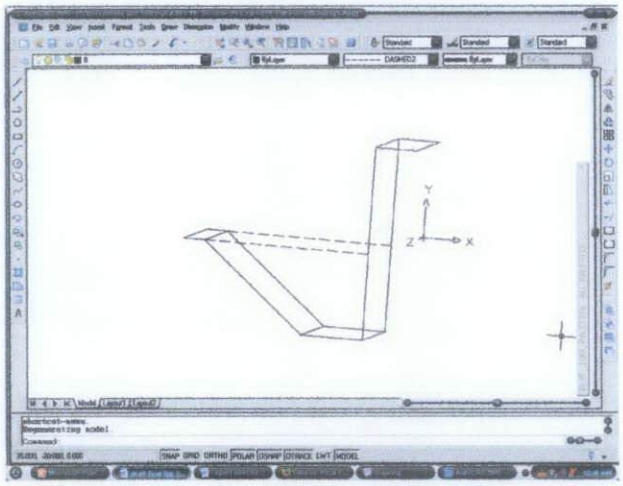


Figure 5.1: 3D drawing of sandtrap solid waste trapping

5.2.1.2 Recommendation 2: Provide bin at specific location

When dealing with litter, illegal dumping should be controlled and managed. Inappropriate storage bins are usually being attacked by stray dogs and cats. These animals may tear apart the rubbish into tiny pieces and scattered them as litter. Thus, the town council should identify appropriate locations for bins in order to prevent illegal dumping of solid waste, such as the one in Figure 5.2. Solid wastes in these bins should be collected on a regular basis. Figure 5.3 shows a type of large solid waste container that may be used to prevent illegal dumping.

Figure 5.2: One of the location of illegal dumping at Taman Teknologi Seri Iskandar

Figure 5.3: Large solid waste container

Reasonable numbers of solid waste container or bin need to be located at the community parks and public area. An appropriate number of the solid waste container is important to show the community that the town council is serious in overcoming the litter issue.

5.2.1.3 Recommendation 3: Street cleaning

The town council should properly schedule a street cleaning. It is recommended for the town council to have at least a few units of litter vacuums for the purpose of street and pavement cleansing. With the availability of the units, the time of the conventional method of cleansing may be reduced. Thus, many areas can be covered in one session of cleaning. Figure 5.4 below shows the type of vacuum that is available in the market.

Figure 5.4: Types of vacuum litter collector

This unit provided a storage capacity that reduced the need for workers to turn back to collection point. Supplied with vacuum hose, these units allow workers to conduct cleaning in areas that are difficult to access.

5.2.2 Management solution

5.2.2.1 Recommendation 4: Improve collection frequency

The frequency of solid waste collection has to be increased especially for the market area, community park and playground area. Town council's workers also need to conduct cleansing activities in community areas on regular basis.

5.2.2.2 Recommendation 5: Permission for poster and advertisement

Town council also must regulate and enforce the issue of advertising permit before any poster and advertisement can be posted in public areas. Without this permit, no poster should be allowed to be posted. Included in the rules and regulations is the responsibilities of the owner of the advertisement to take down the materials after the due date. The permit to post up an advert should come with deposit money for compliances.

5.2.2.3 Recommendation 6: Litter-Spy

For this program, hotline may be introduced for the public to make instant report when they witness littering is being done. The report can be by call or instant text message. The content of the report may include the name or vehicle registration plate of the offenders as well as the location, time and date the offense take place.

5.2.2.4 Recommendation 7: Discourage the plastic usage

Town council may discourage the usage of plastic bag for dry market and shop for reason that plastic is one of the major compositions of litter in Seri Iskandar town. Community should be encouraged to use their own basket or trolley when they go to shop and market. Tax for using plastic may be implemented to shop owner in order to discourage the usage. The tax collected can be used for improving the litter collection system of the area.

5.2.3 Educational solution

5.2.3.1 Recommendation 8: Adopt-A-Park

As Seri Iskandar town become one of the education hub of world standard, the idea of implementing "Adopt-A-Park" may be reasonable. Adapting from Keep America Beauty's project 'Adopt-A-Highway', the main idea of the project is to maintain the cleanliness of the town council with the help of the community. Besides maintaining the cleanliness of the town and the community park areas specifically, implementing this project in Seri Iskandar town also carries the purpose of educating the students from wide range of age on the importance of cleanliness as well as inserting the positive values as they are a part of the community that is responsible for the beauty, clean and healthy environment.

In this program, each universities or schools can be assigned to a specific community park. It is the universities and schools responsibility to form the volunteer group among the students and ensure that this group performs a minimum of three cleanups per year. At the end of every year, certificate will be given to the participant as an encouragement.

5.3 Recommendation for Future Studies

Litter survey is an approach to measure the severity of litter problem especially in a developing area such as Seri Iskandar. Litter survey also can help to determine the suitability of prevention and mitigation steps. This approach can be used by the authority as a common practice to avoid waste in time, effort and money when adopting the unsuitable prevention and mitigation methods. Area with less litter does not require frequent litter collection where as area with high litter especially residential areas need to be provided with services while the park and open areas need to be equipped with storage as well as collection facilities.

Although the project may be realize as Final Year Project, it is recommended to include these surveys as a project in Environment Engineering course or any other subjects as it is very useful in increasing the understanding of the students on current environmental issues and problem in their surrounding area. By implementing this survey as course's project, the university also indirectly contribute to the community as at least once for every semester, there will be a group of students to be involved in litter collection for them to complete the surveys.

This approach also is very useful in assisting the Health Department and Town Council of Bandar Seri Iskandar in establishing the litter index for future reference that is very vital in ensuring continuous improvement in litter rating.

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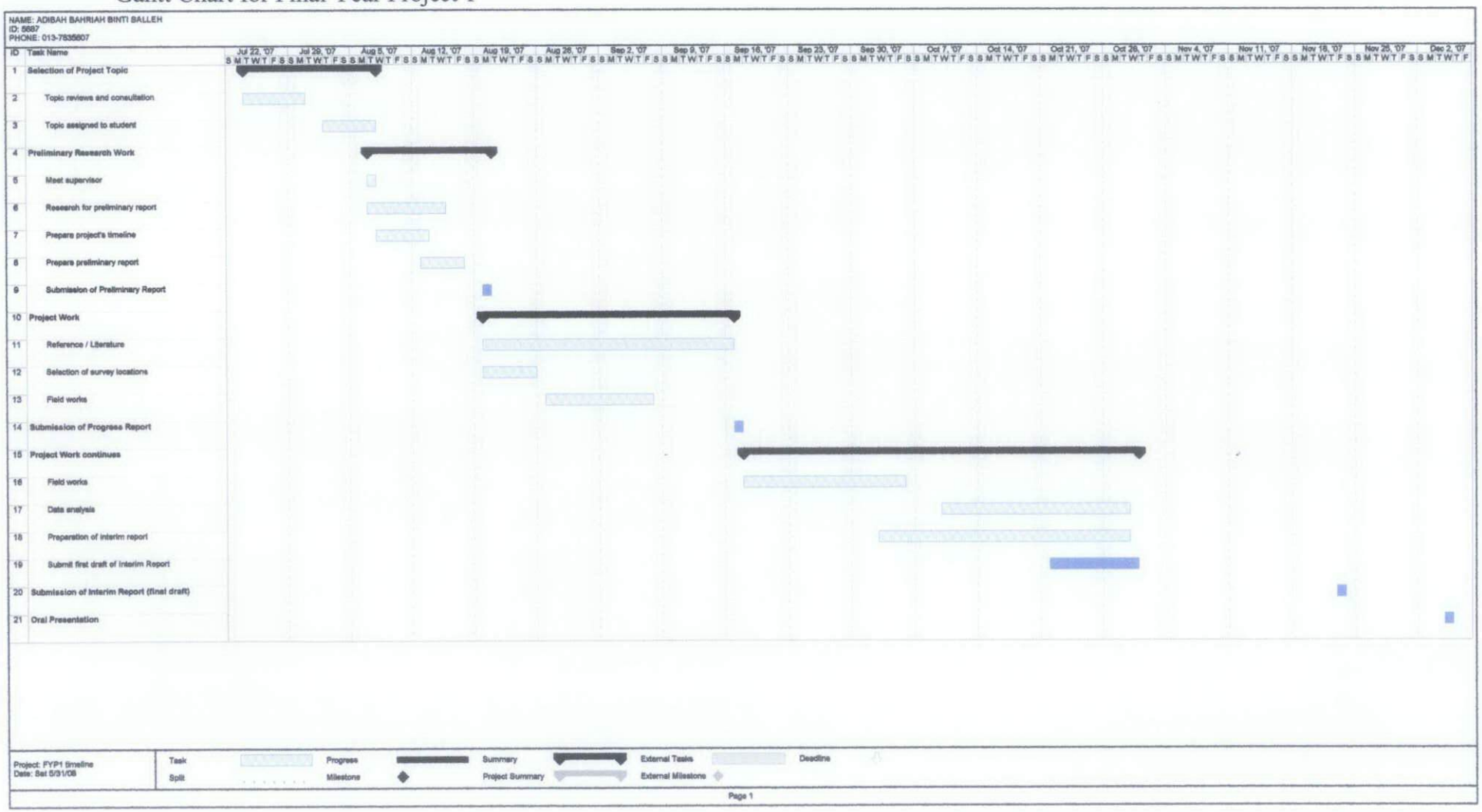
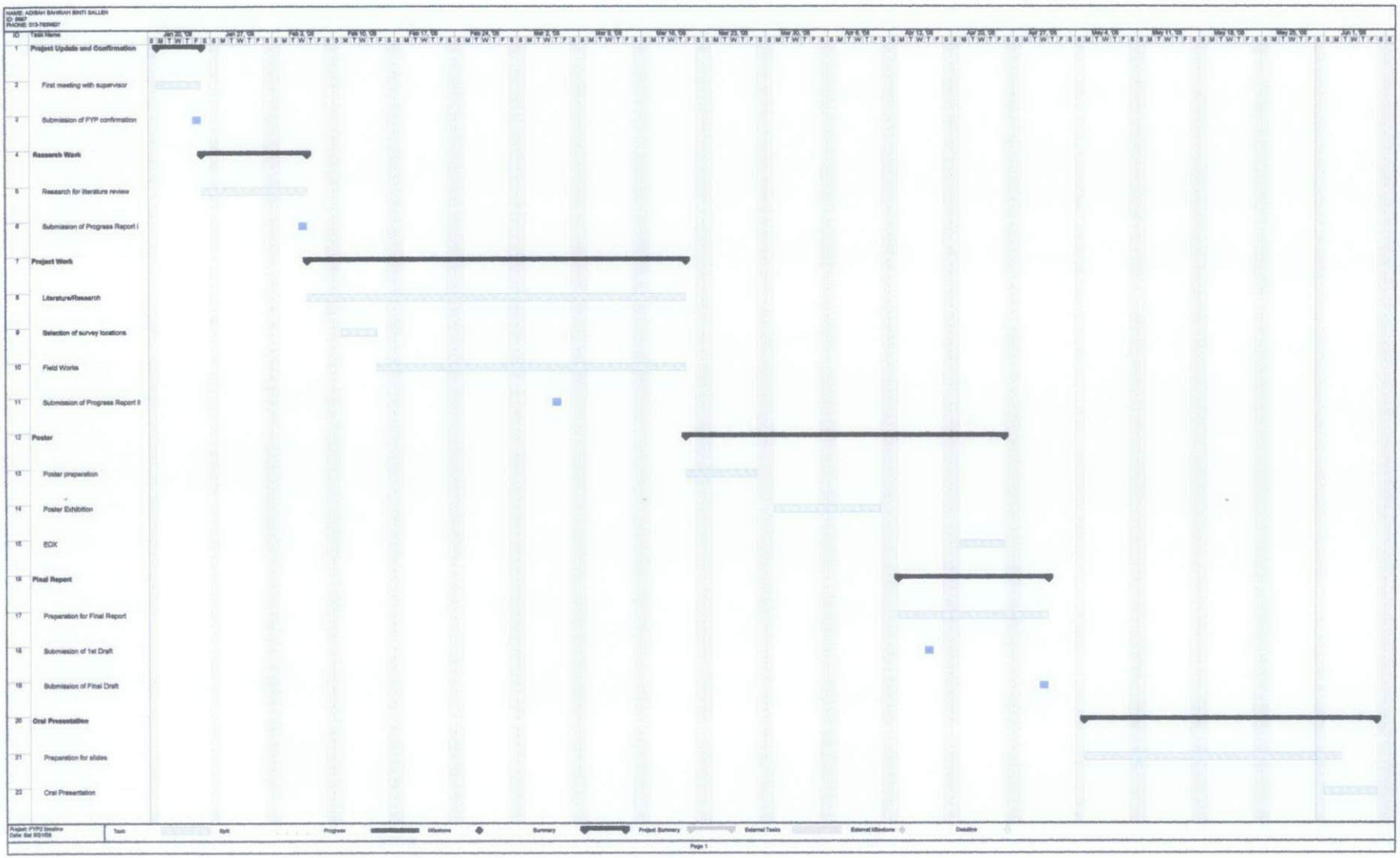
APPENDICES

APPENDIX A: Gantt Chart for Final Year Project

Gantt Chart for Final Year Project 1



Gantt Chart for Final Year Project 2



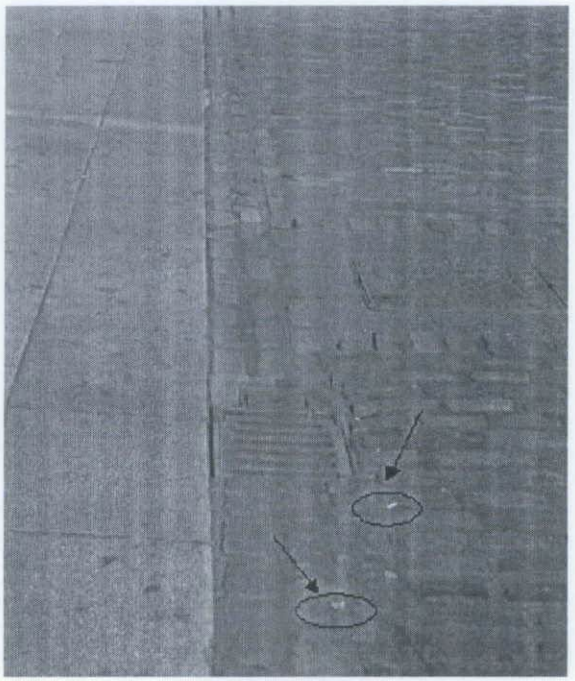
APPENDIX B: Example of Litter Area by Scales

Area Cleanliness Rating 1 (Unpolluted)

This is only given to an area with no litter present i.e. the area maybe freshly swept

Area Cleanliness Rating 2 (Slightly Polluted)

This is only given to an area with small litter items present, i.e. not visually intrusive.



Area Cleanliness Rating 3 (Moderately Polluetd)

This is given to an area with some large litter items present, i.e. visually intrusive.

Area Cleanliness Rating 4 (Significantly Polluted)

This is given to an area with large litter items present throughout the survey area.

Area Cleanliness Rating 5 (Grossly Polluted)

This is given to an area, which is heavily littered throughout the survey area i.e. an event like a Concert / Festival or fly-tipping.

APPENDIX C: Results for Ireland and Georgia Base on Litter Categories

Table C.1: Ireland's Litter Composition 2005 & 2006

	Detailed National Litter Composition 2006		Detailed National Litter Composition 2005	
Cigarette Related Litter	Cigarette ends	49.37%	Cigarette ends	41.79%
	Matches	2.97%	Matches	4.50%
	Cigarette boxes and wrappers	2.88%	Cigarette boxes and wrappers	1.98%
	Matchboxes and lighters	0.43%	Matchboxes and lighters	1.13%
Food Related Litter	Chewing Gum	25.18%	Chewing Gum	31.61%
	Bread/ biscuits	0.51%	Bread/ biscuits	0.12%
	Fast-food remnants	0.22%	Fast-food remnants	0.20%
	Remnants of confectionery food items	0.19%	Remnants of confectionery food items	0.81%
	Fruit/ vegetables	0.17%	Fruit/ vegetables	0.09%
	Other food items	0.15%	Other food items	0.34%
Packaging Items	Bottles (Plastic)	2.06%	Bottles (Plastic)	1.06%
	Bags and wrappers (Takeaway packaging)	1.52%	Bags and wrappers (Takeaway packaging)	2.07%
	Beverage Cans - Non-alcoholic	1.16%	Beverage Cans - Non-alcoholic	0.90%
	Drink cups (Takeaway packaging)	1.04%	Drink cups (Takeaway packaging)	0.70%
	Beverage Cans – Alcoholic	0.80%	Beverage Cans - Alcoholic	0.74%
	Drinks cartons (Paper)	0.82%	Drinks cartons (Paper)	0.50%
	Beverage Bottles - Non-alcoholic (Glass)	0.69%	Beverage Bottles - Non-alcoholic (Glass)	0.61%
	Beverage Bottles - Alcoholic (Glass)	0.65%	Beverage Bottles – Alcoholic (Glass)	0.62%
	Other plastic packaging	0.61%	Other plastic packaging	1.01%
	Paper Bags	0.61%	Paper Bags	0.40%
	Other paper packaging	0.59%	Other paper packaging	1.34%
	Bags - shopping bags	0.52%	Bags - shopping bags	0.22%
	Tin foil (not sweet wrappers)	0.35%	Tin foil (not sweet wrappers)	0.30%
	Plastic film	0.33%	Plastic film	0.19%
	Cardboard	0.18%	Cardboard	0.22%
	Boxes	0.17%	Boxes	0.16%
	Food cans	0.13%	Food cans	0.13%
	Aeroboard	0.13%	Aeroboard	0.06%
	Lids (e.g. from bottles, jars)	0.12%	Lids (e.g. from bottles, jars)	0.24%
	Bubble-wrap	0.10%	Jars and other containers (Glass)	0.08%
	Jars and other containers	0.09%	Bubble-wrap	0.14%
	Other metal litter items	0.07%	Other metal litter items	0.08%
	Bags - other (e.g. fertiliser)	0.03%	Bags - other (e.g. fertiliser)	0.06%
	Plastic sheeting (e.g. silage)	0.02%	Plastic sheeting (e.g. silage)	0.03%
	Metal drums	0.01%	Metal drums	0.04%
Paper Items	Tissues	0.77%	Tissues	0.84%
	Tickets (e.g. bus, lottery)	0.54%	Tickets (e.g. bus, lottery)	0.55%
	Receipts	0.55%	Receipts	0.69%
	Bank slips	0.49%	Bank slips	0.42%
	Other paper items	0.26%	Other paper items	0.44%
	Newspapers	0.14%	Newspapers	0.13%
	Flyers and posters	0.08%	Flyers and posters	0.10%
	Magazines/ brochures	0.07%	Magazines/ brochures	0.10%
	Letters, envelopes and cards	0.06%	Letters, envelopes and cards	0.05%
Miscellaneous	Miscellaneous Litter Items	0.49%	Miscellaneous Litter Items	0.90%
Deleterious Litter	Nappies	0.15%	Nappies	0.07%
	Other deleterious items	0.04%	Other deleterious items	0.13%
	Feminine hygiene products	0.04%	Feminine hygiene products	0.09%
	Municipal Hazardous Waste (e.g. paint, solvents)	0.01%	Municipal Hazardous Waste (e.g. paint, solvents)	0.01%
	Needles and syringes	0.00%	Needles and syringes	0.00%
	Dog fouling	0.81%	Dog fouling	0.51%
Plastic Items	Plastic items	0.33%	Plastic items	0.33%
Large Litter Items	Appliances (e.g. fridge)	0.12%	Appliances (e.g. fridge)	0.01%
	Household refuse in bags	0.09%	Household refuse in bags	0.12%
	Other large items	0.04%	Other large items	0.02%
	Furniture	0.04%	Furniture	0.00%
	Scrap cars	0.01%	Scrap cars	0.01%

Table C.2: Georgia's Litter Composition 2006

Table ES-1
Composition of Litter

Category	Percent
Beer and soft drink containers	3.40%
Juice, wine, liquor, water containers	1.00%
Bottle caps and seals	2.10%
Pull tabs	0.40%
Beverage carriers and cartons	0.30%
Cups, lids, straws	6.70%
Snack food packaging (candy, gum, etc.)	9.40%
Take-out food packaging	3.00%
Cigarette packs, lighters, matches	2.00%
Napkins, bags, tissues	4.60%
Toiletries, toys, drugs	0.80%
Deliberate	**33.70%**
Newspapers, magazines, books	1.10%
Advertising signs and cards	0.60%
Home food packaging (TV dinners, etc.)	0.10%
Vehicle debris and packaging	9.10%
Construction and demolition debris	1.30%
Miscellaneous paper	18.60%
Miscellaneous plastic	22.30%
Miscellaneous metal and foil	8.20%
Miscellaneous glass and ceramics	1.50%
Wood and yard debris	1.70%
Other (carpet, fabric)	1.70%
Negligent	**66.30%**
Total	**100.00%**

APPENDIX D: Results for Litter Survey on Open Areas

Table D.1: Table of number and weight of litter by categories for Area A

Categories	No. of Items	Weight (g)
Plastic Bag	76	209.27
Plate	52	80.01
Food Wrapper	455	548.50
Packet Drink	20	237.67
Plastic Bottle	10	243.70
Glass Bottle	1	142.02
Straw	34	19.21
Paper	20	53.84
Tin	4	54.50
Box	19	134.90
Cigarette Box	49	296.94
Cup	16	102.73
Clothes	3	73.55
Others	62	767.08
Total	**821**	**2963.92**

Table D.2: Table of number and weight of litter by categories for Area B

Categories	No. of Items	Weight (g)
Plastic Bag	42	105.57
Plate	1	1.53
Food Wrapper	112	187.26
Packet Drink	18	207.50
Plastic Bottle	15	356.24
Glass Bottle	3	412.07
Straw	32	17.09
Paper	18	42.03
Tin	7	122.78
Box	6	11.36
Cigarette Box	16	81.30
Cup	14	133.33
Clothes	3	60.72
Others	47	143.94
Total	**334**	**1882.72**